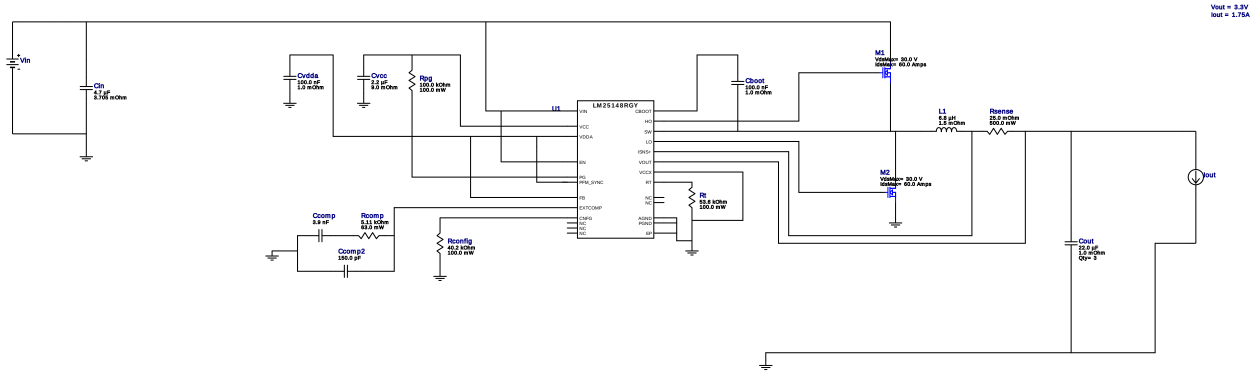
TEXAS INSTRUMENTS

WEBENCH ® Design Report

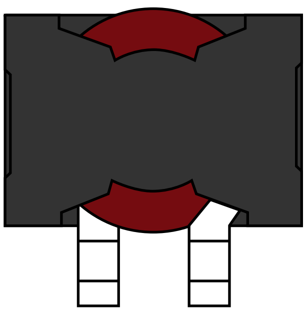
VinMin = 5.0V
VinMax = 7.4V
Vout = 3.3V
Iout = 1.75A

Device = LM25148RGYR
Topology = Buck
Created = 2025-03-14 15:37:15.668
BOM Cost = $3.18
BOM Count = 18
Total Pd = 0.14W

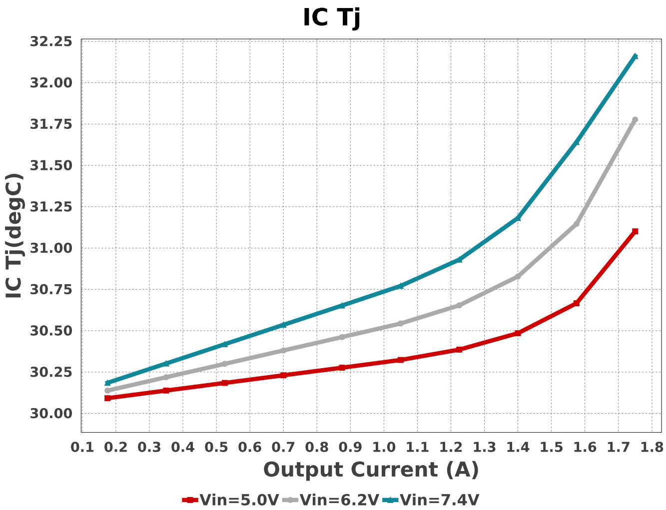
Design : 46 LM25148RGYR
LM25148RGYR 5V-7.4V to 3.30V @ 1.75A

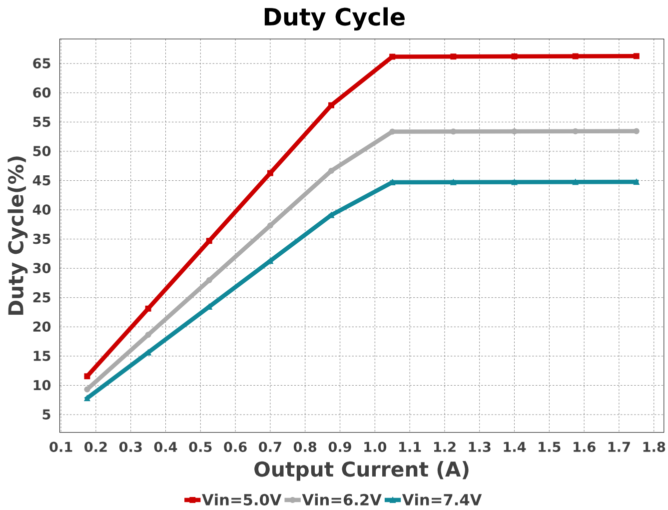


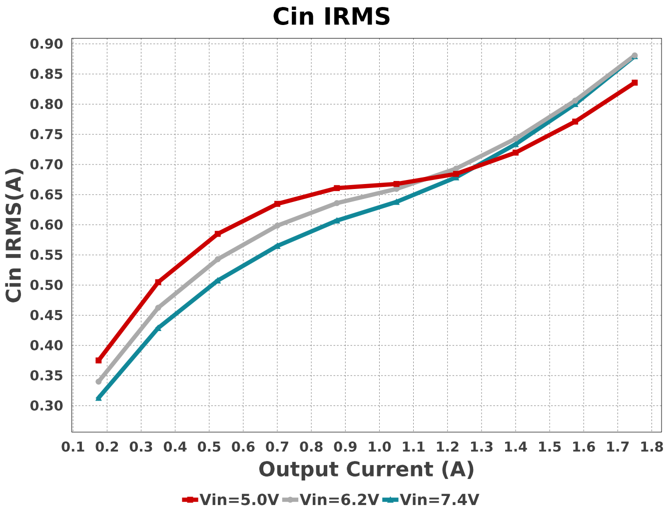
Electrical BOM

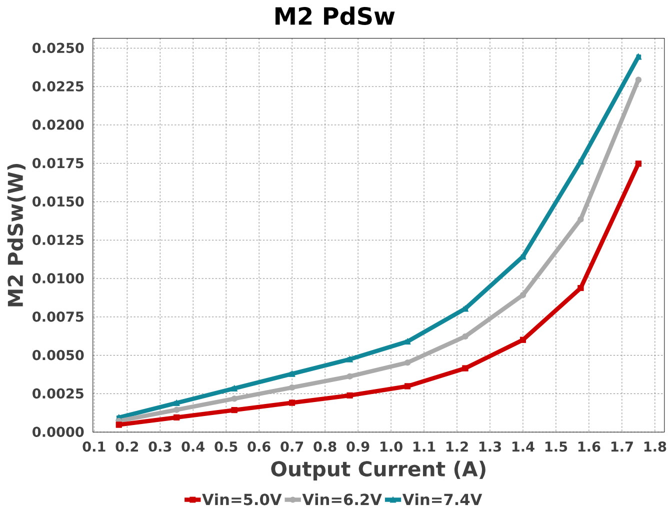
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	MuRata	GRM155R71A104KA01D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Ccomp	TDK	CGA4C2C0G1H392J060AA Series= C0G/NP0	Cap= 3.9 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.04	0805 7 mm²
Ccomp2	Taiyo Yuden	UMK105CG151JV-F Series= C0G/NP0	Cap= 150.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cin	MuRata	GRM31CR61C475KA01L Series= X5R	Cap= 4.7 uF ESR= 3.705 mOhm VDC= 16.0 V IRMS= 3.07145 A	1	$0.08	1206_190 11 mm²
Cout	MuRata	GRM188R60J226MEA0D Series= X5R	Cap= 22.0 uF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 6.0 A	3	$0.04	0603 5 mm²
Cvcc	MuRata	GRM188R71A225KE15D Series= X7R	Cap= 2.2 uF ESR= 9.0 mOhm VDC= 10.0 V IRMS= 3.3 A	1	$0.02	0603 5 mm²
Cvdda	MuRata	GRM155R71A104KA01D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
L1	Coilcraft	SER2915L-682KL	L= 6.8 µH 1.5 mOhm	1	$1.88	 SER2915L 652 mm²

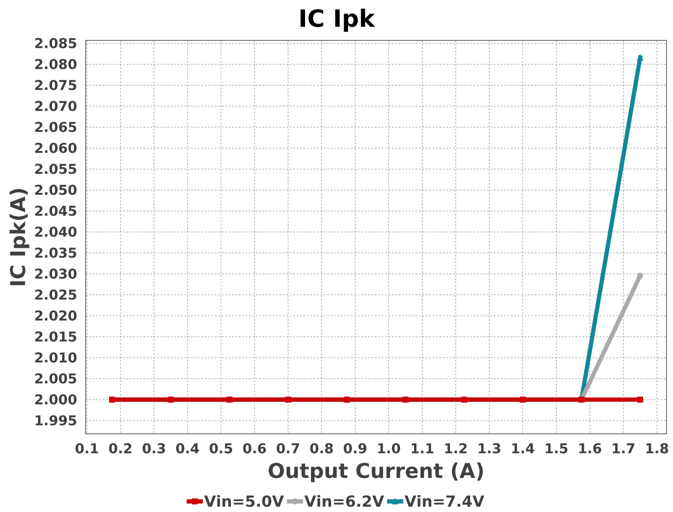
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
M1	Texas Instruments	CSD17577Q5A	VdsMax= 30.0 V IdsMax= 60.0 Amps	1	$0.17	TRANS_NexFET_Q5A 55 mm^2
M2	Texas Instruments	CSD17577Q5A	VdsMax= 30.0 V IdsMax= 60.0 Amps	1	$0.17	TRANS_NexFET_Q5A 55 mm^2
Rcomp	Vishay-Dale	CRCW04025K11FKED Series= CRCW..e3	Res= 5.11 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rconfig	Vishay-Dale	CRCW060340K2FKEA Series= CRCW..e3	Res= 40.2 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rpg	Vishay-Dale	CRCW0603100KFKEA Series= CRCW..e3	Res= 100.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rsense	Stackpole Electronics Inc	CSR1206FK25L0 Series= ?	Res= 25.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.10	1206 11 mm^2
Rt	Vishay-Dale	CRCW060353K6FKEA Series= CRCW..e3	Res= 53.6 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
U1	Texas Instruments	LM25148RGYR	Switcher	1	$0.53	RGY0024E-MFG 48 mm^2

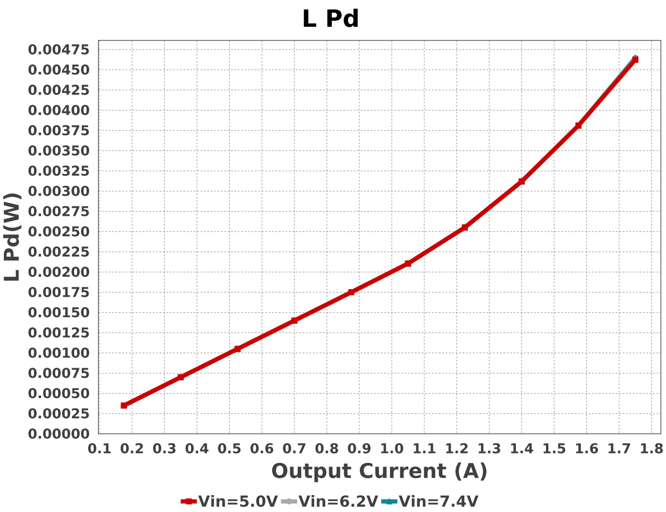


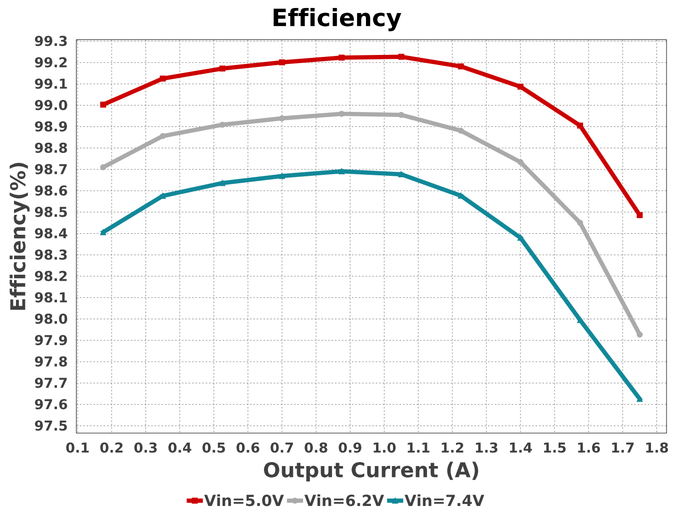


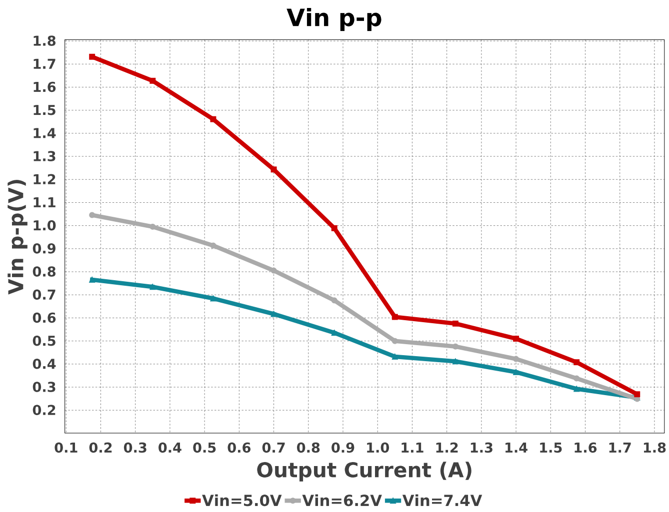


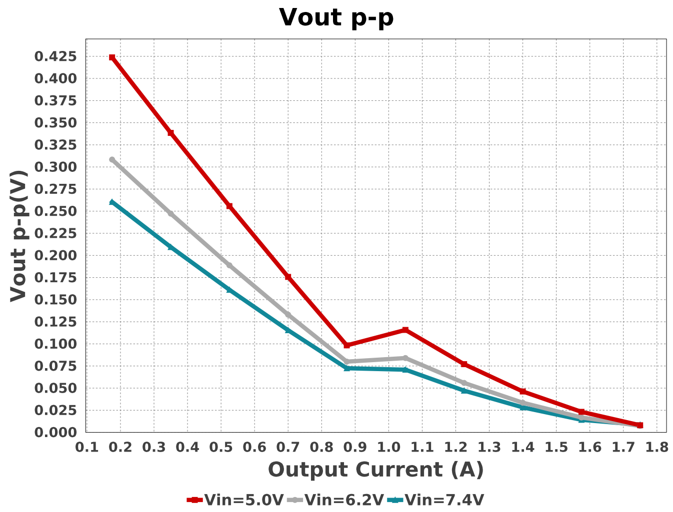


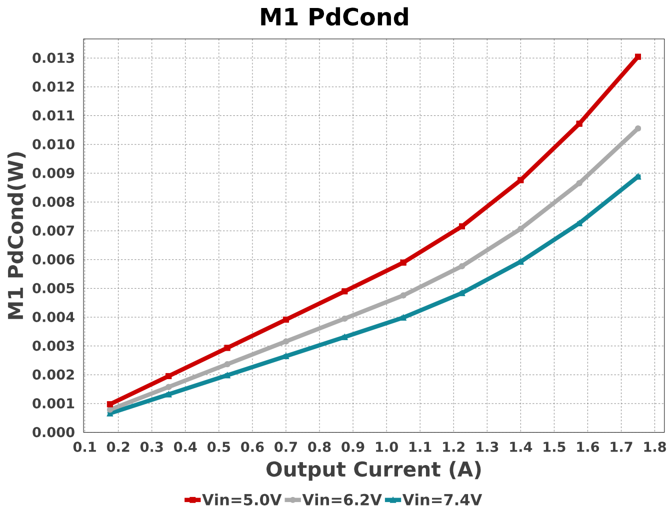

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=5.0V Vin=6.2V Vin=7.4V

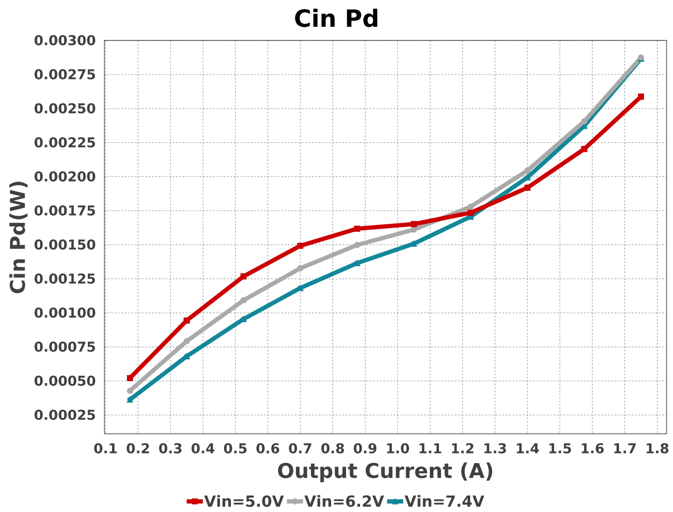

L Pd
L Pd(W)
Output Current (A)
Vin=5.0V Vin=6.2V Vin=7.4V

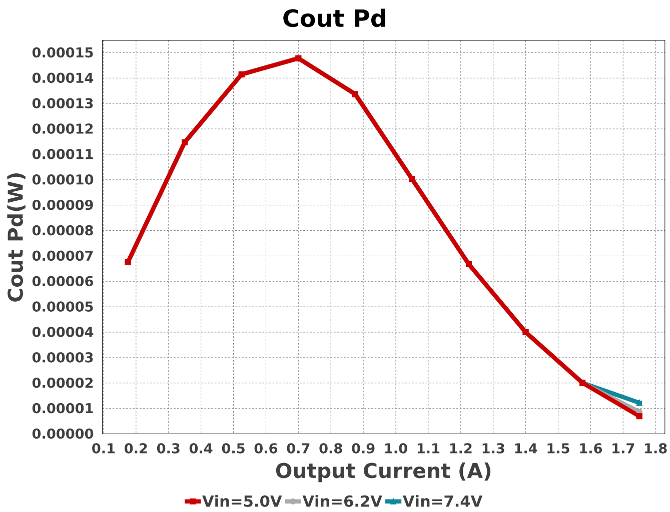

Efficiency
Efficiency(%)
Output Current (A)
Vin=5.0V Vin=6.2V Vin=7.4V

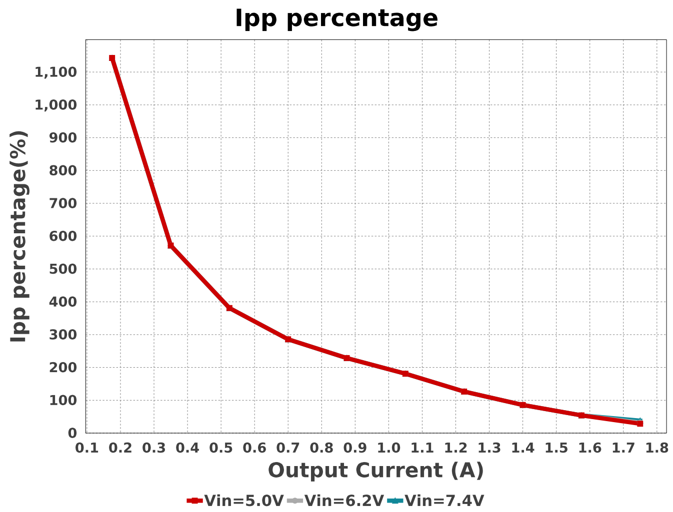

Vin p-p
Vin p-p(V)
Output Current (A)
Vin=5.0V Vin=6.2V Vin=7.4V

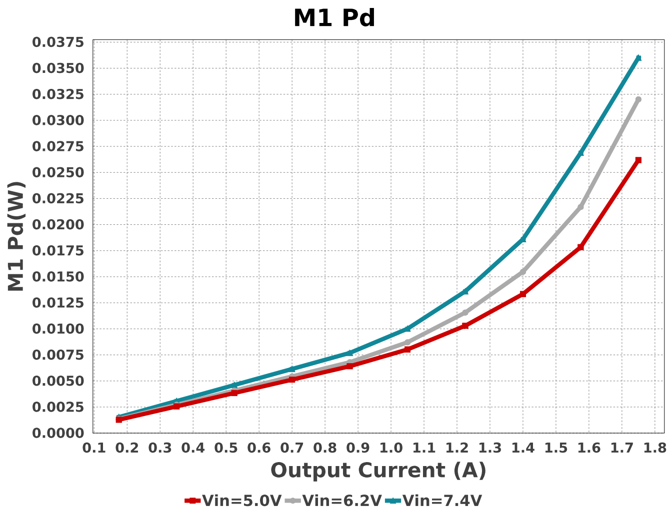

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=5.0V Vin=6.2V Vin=7.4V

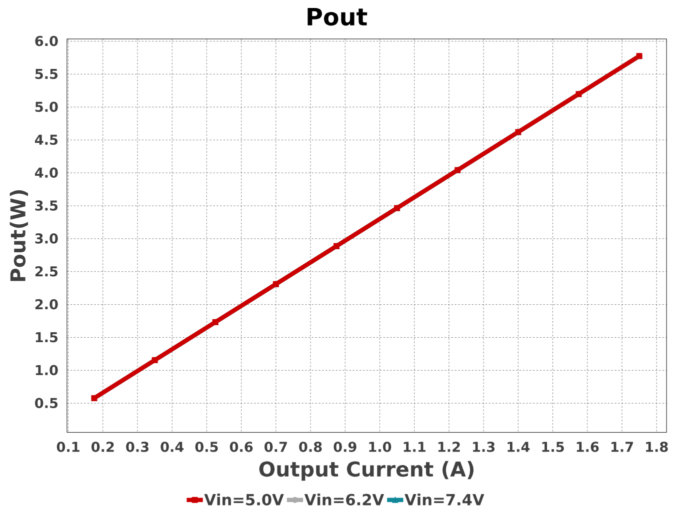

M1 PdCond
M1 PdCond(W)
Output Current (A)
Vin=5.0V Vin=6.2V Vin=7.4V

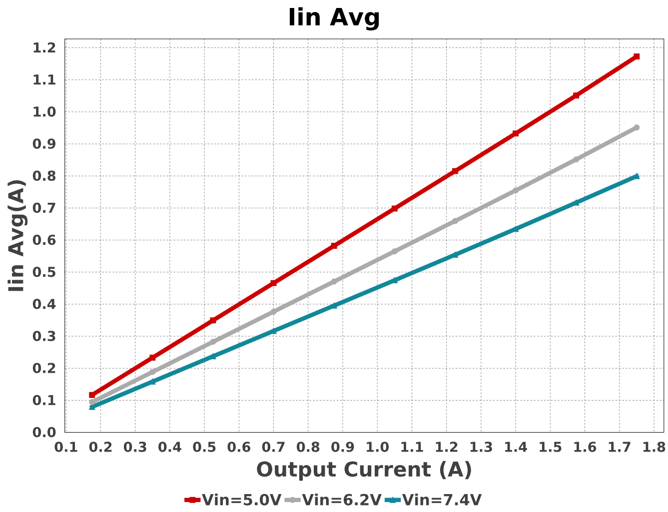

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=5.0V Vin=6.2V Vin=7.4V


Cout Pd
Cout Pd(W)
Output Current (A)
Vin=5.0V Vin=6.2V Vin=7.4V

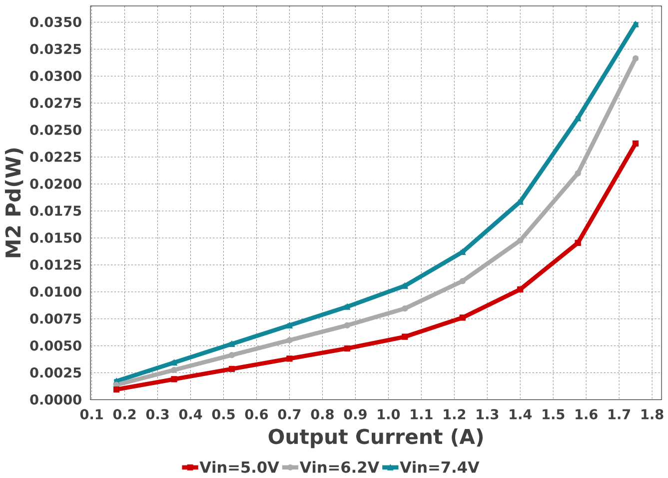

Ipp percentage
Ipp percentage(%)
Output Current (A)
Vin=5.0V Vin=6.2V Vin=7.4V


M1 Pd
M1 Pd(W)
Output Current (A)
Vin=5.0V Vin=6.2V Vin=7.4V

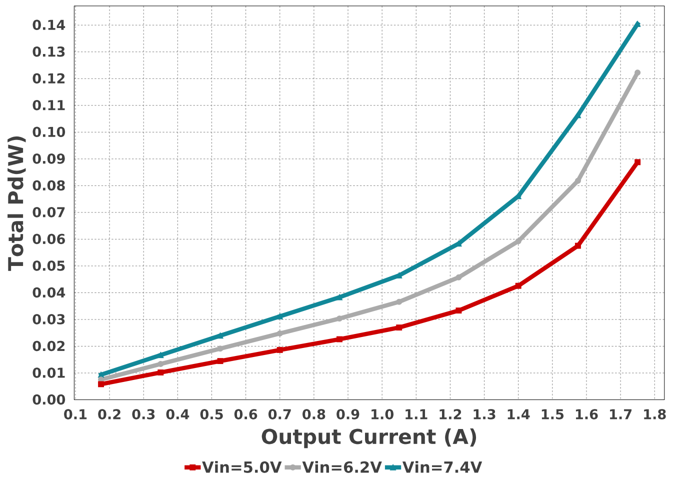

Pout
Pout(W)
Output Current (A)
Vin=5.0V Vin=6.2V Vin=7.4V


Iin Avg
Iin Avg(A)
Output Current (A)
Vin=5.0V Vin=6.2V Vin=7.4V

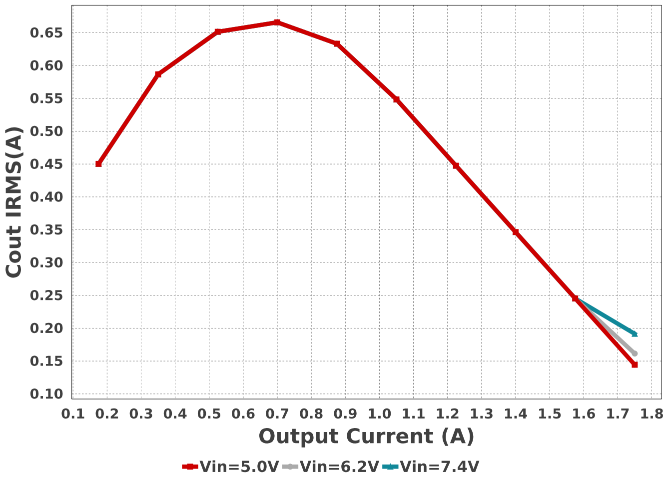
M2 Pd



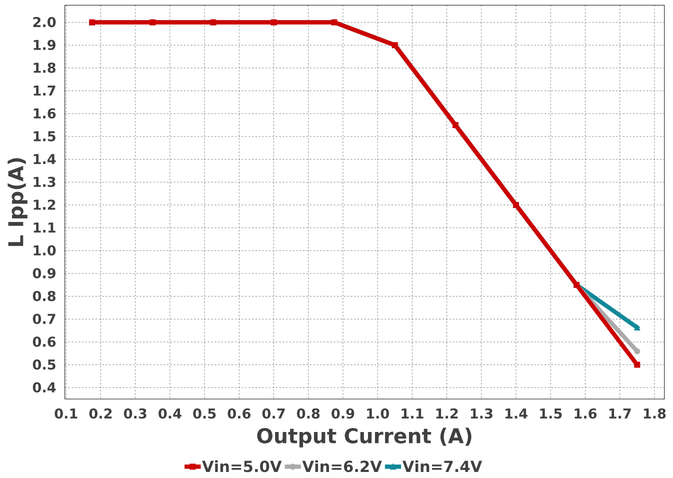
Total Pd



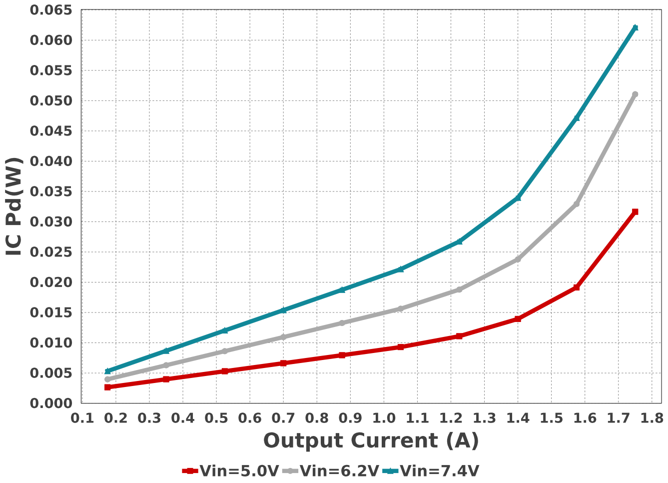
Cout IRMS



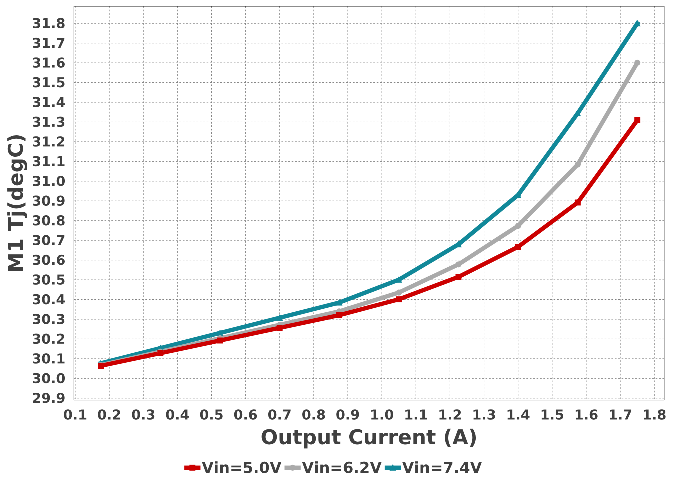
L Ipp

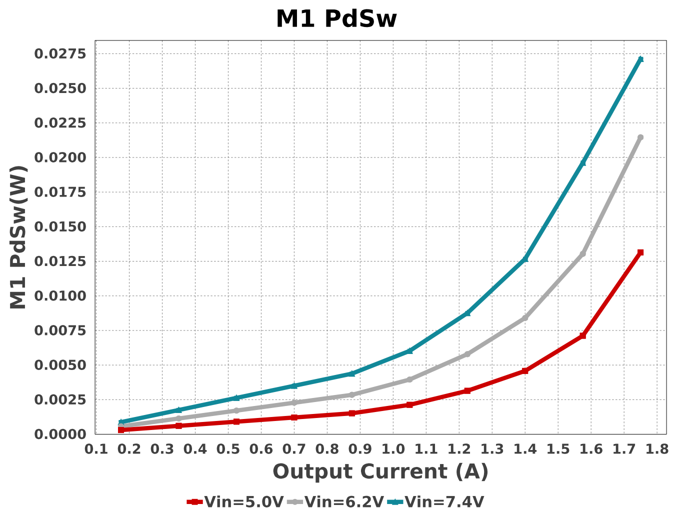


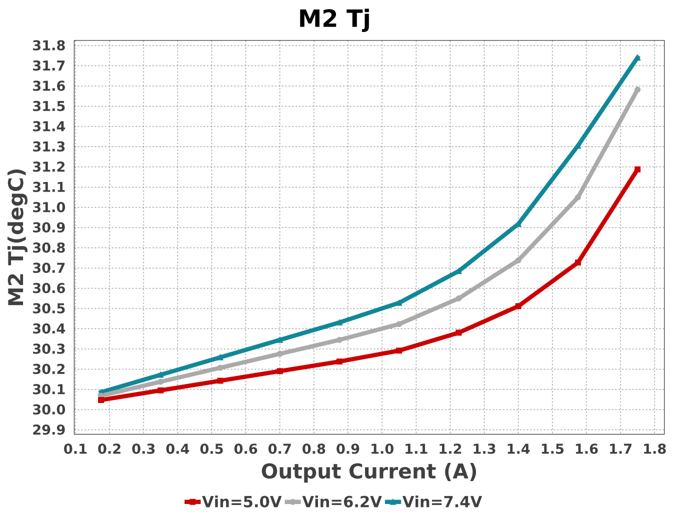
IC Pd

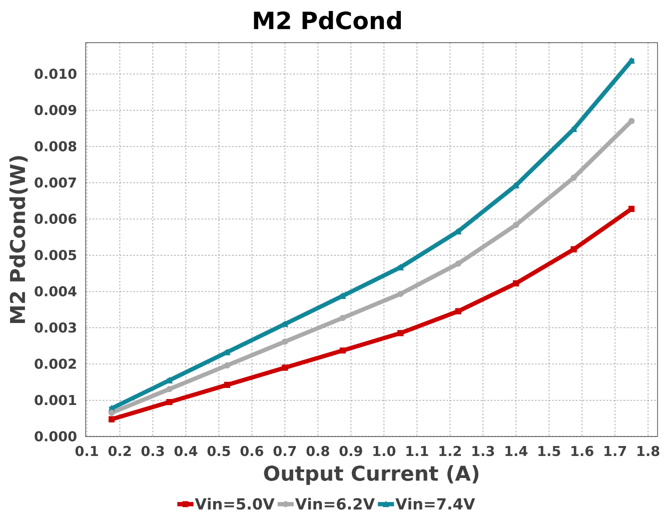


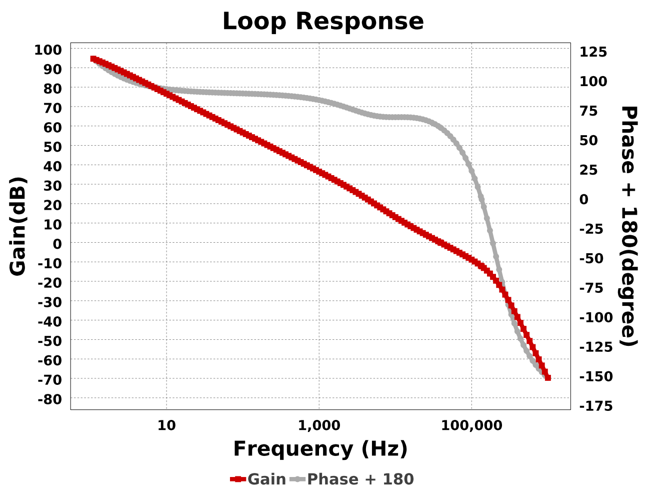
M1 Tj

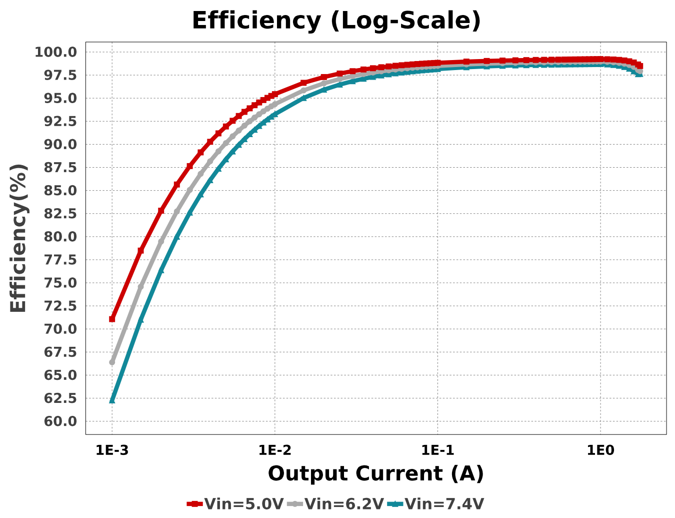












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	879.594 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	2.867 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	191.465 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	12.22 µW	Capacitor	Output capacitor power dissipation
5.	IC Ipk	2.082 A	IC	Peak switch current in IC
6.	IC Pd	62.095 mW	IC	IC power dissipation
7.	IC Tj	32.161 degC	IC	IC junction temperature
8.	IC Tolerance	33.0 mV	IC	IC Feedback Tolerance
9.	ICThetaJA Effective	34.8 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
10.	Iin Avg	799.38 mA	IC	Average input current

#	Name	Value	Category	Description
11.	Ipp percentage	37.9 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
12.	L Ipp	663.25 mA	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	4.649 mW	Inductor	Inductor power dissipation
14.	M1 Pd	36.001 mW	Mosfet	M1 MOSFET total power dissipation
15.	M1 PdCond	8.884 mW	Mosfet	M1 MOSFET conduction losses
16.	M1 PdSw	27.117 mW	Mosfet	M1 MOSFET switching losses
17.	M1 Tj	31.8 degC	Mosfet	M1 MOSFET junction temperature
18.	M2 Pd	34.813 mW	Mosfet	M2 MOSFET total power dissipation
19.	M2 PdCond	10.369 mW	Mosfet	M2 MOSFET conduction losses
20.	M2 PdSw	24.444 mW	Mosfet	M2 MOSFET switching losses
21.	M2 Tj	31.741 degC	Mosfet	M2 MOSFET junction temperature
22.	Cin Pd	2.867 mW	Power	Input capacitor power dissipation
23.	Cout Pd	12.22 µW	Power	Output capacitor power dissipation
24.	IC Pd	62.095 mW	Power	IC power dissipation
25.	L Pd	4.649 mW	Power	Inductor power dissipation
26.	M1 Pd	36.001 mW	Power	M1 MOSFET total power dissipation
27.	M1 PdCond	8.884 mW	Power	M1 MOSFET conduction losses
28.	M1 PdSw	27.117 mW	Power	M1 MOSFET switching losses
29.	M2 Pd	34.813 mW	Power	M2 MOSFET total power dissipation
30.	M2 PdCond	10.369 mW	Power	M2 MOSFET conduction losses
31.	M2 PdSw	24.444 mW	Power	M2 MOSFET switching losses
32.	Total Pd	140.432 mW	Power	Total Power Dissipation
33.	BOM Count	18	System Information	Total Design BOM count
34.	Cross Freq	38.885 kHz	System Information	Bode plot crossover frequency
35.	Duty Cycle	44.777 %	System Information	Duty cycle
36.	Efficiency	97.626 %	System Information	Steady state efficiency
37.	FootPrint	884.0 mm^2	System Information	Total Foot Print Area of BOM components
38.	Frequency	405.68 kHz	System Information	Switching frequency
39.	Gain Marg	-12.285 dB	System Information	Bode Plot Gain Margin
40.	Iout	1.75 A	System Information	Iout operating point
41.	Iout transient step used for Cout calculations	875.0 mA	System Information	Custom Transient current step requirement that was used for Cout selection (A).
42.	Low Freq Gain	94.647 dB	System Information	Gain at 1Hz
43.	Mode	CCM	System Information	Conduction Mode
44.	Overshoot Value	33.313 mV	System Information	Theoretical Vout Overshoot Value
45.	Phase Marg	60.953 deg	System Information	Bode Plot Phase Margin
46.	Pout	5.775 W	System Information	Total output power
47.	Total BOM	$3.18	System Information	Total BOM Cost
48.	Undershoot Value	77.279 mV	System Information	Theoretical Vout Undershoot Value
49.	Vin	7.4 V	System Information	Vin operating point
50.	Vin p-p	254.872 mV	System Information	Peak-to-peak input voltage
51.	Vout	3.3 V	System Information	Operational Output Voltage
52.	Vout Ripple requirement used for Cout calculations	500.0 m%	System Information	Custom maximum output ripple requirement that was used for Cout selection(% of Vout).
53.	Vout Tolerance	1.0 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
54.	Vout p-p	8.632 mV	System Information	Peak-to-peak output ripple voltage
55.	Vout transient requirement used for Cout calculations	3.0 %	System Information	Custom Transient voltage change requirement that was used for Cout selection (% of Vout).

Design Inputs

Name	Value	Description
Iout	1.75	Maximum Output Current

Name	Value	Description
VinMax	7.4	Maximum input voltage
VinMin	5.0	Minimum input voltage
Vout	3.3	Output Voltage
base_pn	LM25148	Base Product Number
source	DC	Input Source Type
Ta	30.0	Ambient temperature
UserFsw	406.0 k	Customer Selected Frequency

WEBENCH® Assembly

Component Testing

Some published data on components in datasheets such as Capacitor ESR and Inductor DC resistance is based on conservative values that will guarantee that the components always exceed the specification. For design purposes it is usually better to work with typical values. Since this data is not always available it is a good practice to measure the Capacitance and ESR values of Cin and Cout, and the inductance and DC resistance of L1 before assembly of the board. Any large discrepancies in values should be electrically simulated in WEBENCH to check for instabilities and thermally simulated in WebTHERM to make sure critical temperatures are not exceeded.

Soldering Component to Board

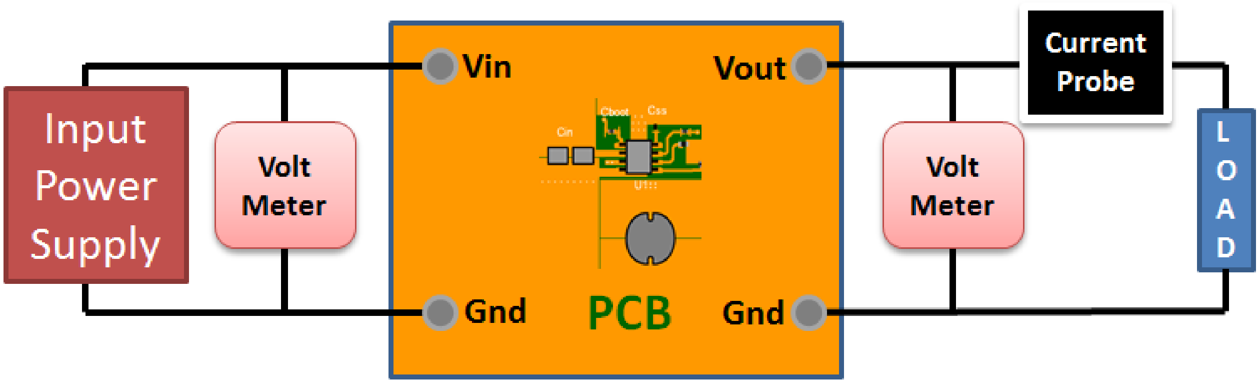
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. To solder the tab town to the board place the iron down on the board while resting against the tab, heating both surfaces simultaneously. Apply light pressure to the top of the plastic case until the solder flows around the part and the part is flush with the PCB. If the solder is not flowing around the board you may need a higher wattage iron (generally 25W to 30W is enough).

Initial Startup of Circuit

It is best to initially power up the board by setting the input supply voltage to the lowest operating input voltage 5.0V and set the input supply's current limit to zero. With the input supply off connect up the input supply to Vin and GND. Connect a digital volt meter and a load if needed to set the minimum Iout of the design from Vout and GND. Turn on the input supply and slowly turn up the current limit on the input supply. If the voltage starts to rise on the input supply continue increasing the input supply current limit while watching the output voltage. If the current increases on the input supply, but the voltage remains near zero, then there may be a short or a component misplaced on the board. Power down the board and visually inspect for solder bridges and recheck the diode and capacitor polarities. Once the power supply circuit is operational then more extensive testing may include full load testing, transient load and line tests to compare with simulation results.

Load Testing

The setup is the same as the initial startup, except that an additional digital voltmeter is connected between Vin and GND, a load is connected between Vout and GND and a current meter is connected in series between Vout and the load. The load must be able to handle at least rated output power + 50% (7.5 watts for this design). Ideally the load is supplied in the form of a variable load test unit. It can also be done in the form of suitably large power resistors. When using an oscilloscope to measure waveforms on the prototype board, the ground leads of the oscilloscope probes should be as short as possible and the area of the loop formed by the ground lead should be kept to a minimum. This will help reduce ground lead inductance and eliminate EMI noise that is not actually present in the circuit.



Design Assistance

1. Master key : 27AFC3A06A218B6F8EA41ED3B4C0DDB7[v1]

2. **LM25148** Product Folder : http://www.ti.com/product/LM25148 : contains the data sheet and other resources.

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